Related Pending Application
Related Case Serial No: 10/159,101
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WHAT IS CLAIMED AS NEW AND DESIRED TO BE SECURED BY LETTERS PATENT OF THE UNITED STATES IS:

1. An arrayed waveguide grating optical multiplexer/demultiplexer comprising:

at least one first optical waveguide;

a first slab waveguide including first and second portions which are divided along an intersecting face intersecting an optical path in the first slab waveguide;

an arrayed waveguide connected to said at least one first optical waveguide via said first slab waveguide;

a second slab waveguide;

a plurality of second optical waveguides connected to said arrayed waveguide via said second slab waveguide; and

a slider fixed at a temperature shifted from a predetermined temperature to compensate a center wavelength difference between a target center wavelength of optical transmission of the arrayed waveguide grating optical multiplexer/demultiplexer at the predetermined temperature and the measured center wavelength of optical transmission of the arrayed waveguide grating optical multiplexer/demultiplexer at the predetermined temperature before the first slab waveguide is divided to the first and second portions, the slider being configured to cause a relative motion between the first and second portions of the first slab waveguide along the intersecting face according to a temperature change.

2. An arrayed waveguide grating optical multiplexer/demultiplexer according to Claim 1, wherein the at least one first optical waveguide, the first slab waveguide, the arrayed waveguide, the second slab waveguide, and the plurality of second optical waveguides are formed in a waveguide forming region, and wherein the slider has a thermal expansion coefficient higher than that of the waveguide forming region.

3. An arrayed waveguide grating optical multiplexer/demultiplexer according to Claim 1, wherein the intersecting face substantially vertically intersects the optical path.

4. An arrayed waveguide grating optical multiplexer/demultiplexer according to Claim 1, wherein the at least one first optical waveguide, the first slab waveguide, the arrayed waveguide, the second slab waveguide, and the plurality of second optical waveguides are formed in a waveguide forming region, and wherein dopant is doped in the waveguide forming region such that an absolute value of a birefringence of core of the waveguide forming region is at most $5.34 \times 10^{-5}$.

5. An arrayed waveguide grating optical multiplexer/demultiplexer according to Claim 4, wherein the dopant comprises $B_2O_3$ and $P_2O_5$.

6. An arrayed waveguide grating optical multiplexer/demultiplexer according to Claim 1, further comprising:

matching oil provided in a gap formed between the first and second portions and having a refractive index which matches with that of a waveguide forming region in which the at least one first optical waveguide, the first slab waveguide, the arrayed waveguide, the second slab waveguide, and the plurality of second optical waveguides are formed.

7. An arrayed waveguide grating optical multiplexer/demultiplexer according to Claim 1, wherein the slider has a length between fixed parts which are fixed to the first and second portions to compensate a temperature dependency of a center wavelength of the arrayed waveguide grating optical multiplexer/demultiplexer.

8. An arrayed waveguide grating optical multiplexer/demultiplexer according to Claim 1, wherein the temperature is shifted from the predetermined temperature by substantially a shifting temperature ($\Delta t$) which is calculated according to the following equation:

$\Delta t = (\lambda_d - \lambda_m) / 0.011$

where $\lambda_d$: the target center wavelength of optical transmission at the predetermined temperature

$\lambda_m$: the measured center wavelength of optical transmission of the arrayed waveguide grating optical multiplexer/demultiplexer at the predetermined temperature before the first slab waveguide is divided into the first and second portions.

9. An arrayed waveguide grating optical multiplexer/demultiplexer according to Claim 1, further comprising:

a half-wave plate provided across the array waveguide.

10. An arrayed waveguide grating optical multiplexer/demultiplexer according to Claim 1, wherein the intersecting face obliquely intersects the optical path.

11. An arrayed waveguide grating optical multiplexer/demultiplexer according to Claim 1, further comprising:

at least one clip; and

a base to which one of the first and second portions of the first slab waveguide is fixed with the at least one clip.

12. An arrayed waveguide grating optical multiplexer/demultiplexer according to Claim 1, wherein

the at least one first optical waveguide, the first slab waveguide, the arrayed waveguide, the second slab waveguide, and the plurality of second optical waveguides are formed in a waveguide forming region,

the waveguide forming region is divided to first and second waveguide forming regions to divide the first slab waveguide to the first and second portions, and

the slider is fixed to the first and second waveguide forming regions to connect the first and second waveguide forming regions at the temperature shifted from the predetermined temperature.

13. An arrayed waveguide grating optical multiplexer/demultiplexer according to Claim 1, wherein

the at least one first optical waveguide, the first slab waveguide, the arrayed waveguide, the second slab waveguide, and the plurality of second optical waveguides are formed in a waveguide forming region,

the waveguide forming region is divided to first and second waveguide forming regions to divide the first slab waveguide to the first and second portions,

one of the first and second waveguide forming regions is fixed to a base, and

the slider is fixed to the base and another of the first and second waveguide forming regions to connect the base and the another of the first and second waveguide forming regions at the temperature shifted from the predetermined temperature.

14. An arrayed waveguide grating optical multiplexer/demultiplexer according to Claim 13, wherein the base has a U-Shape.

15. An arrayed waveguide grating optical multiplexer/demultiplexer according to Claim 12, wherein the waveguide forming region is divided to first and second waveguide forming regions along the intersecting face and a non-intersecting face which does not intersect the optical path, and wherein the slider is fixed to the first and second waveguide forming regions across the non-intersecting face.

16. An arrayed waveguide grating optical multiplexer/demultiplexer according to Claim 12, wherein the slider is fixed to the first and second waveguide forming regions such that a longitudinal direction of the slider is substantially parallel to the intersecting face.

17. A method for manufacturing an arrayed waveguide grating optical multiplexer/demultiplexer, the method comprising:

providing an arrayed waveguide grating including at least one first optical waveguide, a first slab waveguide, an arrayed waveguide connected to said at least one first optical waveguide via said first slab waveguide, a second slab waveguide, and a plurality of second optical waveguides connected to said arrayed waveguide via said second slab waveguide;

measuring a measured center wavelength of optical transmission of the arrayed waveguide grating at a predetermined temperature;

finding a center wavelength difference between a target center wavelength of optical transmission of the arrayed waveguide grating at the predetermined temperature and the measured center wavelength;

dividing at least one of the first and second slab waveguides to first and second portions along an intersecting face intersecting an optical path in the at least one of the first and second slab waveguides; and

fixing a slider at a temperature shifted from the predetermined temperature to compensate the center wavelength difference such that the slider causes a relative motion between the first and second portions along the intersecting face according to a temperature change.

18. A method according to Claim 17, wherein the at least one first optical waveguide, the first slab waveguide, the arrayed waveguide, the second slab waveguide, and the plurality of second optical waveguides are formed in a waveguide forming region, and wherein the slider has a thermal expansion coefficient higher than that of the waveguide forming region.

19. A method according to Claim 17, wherein the intersecting face substantially vertically intersects the optical path.

20. A method according to Claim 17, wherein the at least one first optical waveguide, the first slab waveguide, the arrayed waveguide, the second slab waveguide, and the plurality of second optical waveguides are formed in a waveguide forming region, and wherein dopant is doped in the waveguide forming region such that an absolute value of a birefringence of core of the waveguide forming region is at most $5.34 \times 10^{-5}$.

21. A method according to Claim 20, wherein the dopant comprises $B_2O_3$ and $P_2O_5$.

22. A method according to Claim 17, further comprising:

providing matching oil in a gap formed between the first and second portions, the matching oil having a refractive index which matches with that of a waveguide forming region in which the at least one first optical waveguide, the first slab waveguide, the arrayed waveguide, the second slab waveguide, and the plurality of second optical waveguides are formed.

23. A method according to Claim 17, wherein a length of the slider between fixed parts which are fixed to the first and second portions are determined to compensate a temperature dependency of a center wavelength of the arrayed waveguide grating.

24. A method according to Claim 17, wherein the temperature is shifted from the predetermined temperature by substantially a shifting temperature ($\Delta t$) which is calculated according to the following equation:

$$\Delta t = (\lambda_d - \lambda_m) / 0.011$$

where $\lambda_d$: the target center wavelength of optical transmission at the predetermined temperature

$\lambda_m$: the measured center wavelength of optical transmission of the arrayed waveguide grating optical multiplexer/demultiplexer at the predetermined temperature before the first slab waveguide is divided into the first and second

portions.

25. A method according to Claim 17, further comprising:

providing a half-wave plate across the array waveguide.

26. A method according to Claim 17, wherein the intersecting face is provided to obliquely intersect the optical path.

27. A method according to Claim 17, further comprising:

fixing one of the first and second portions to a base with at least one clip.

28. A method according to Claim 17, wherein

the at least one first optical waveguide, the first slab waveguide, the arrayed waveguide, the second slab waveguide, and the plurality of second optical waveguides are formed in a waveguide forming region,

the waveguide forming region is divided to first and second waveguide forming regions to divide the at least one of the first and second slab waveguides to the first and second portions, and

the slider is fixed to the first and second waveguide forming regions to connect the first and second waveguide forming regions at the temperature shifted from the predetermined temperature.

29. A method according to Claim 17, wherein

the at least one first optical waveguide, the first slab waveguide, the arrayed waveguide, the second slab waveguide, and the plurality of second optical waveguides are formed in a waveguide forming region,

the waveguide forming region is divided to first and second waveguide forming regions to divide the at least one of the first and second slab waveguides to the first and second portions,

one of the first and second waveguide forming regions is fixed to a base, and

the slider is fixed to the base and another of the first and second waveguide forming regions to connect the base and the another of the first and second waveguide forming regions at the temperature shifted from the predetermined temperature.

30. A method according to Claim 29, further comprising:

forming the base in a U-Shape.

31. A method according to Claim 28, wherein the waveguide forming region is divided to first and second waveguide forming regions along the intersecting face and a non-intersecting face which does not intersect the optical path, and wherein the slider is fixed to the first and second waveguide forming regions across the non-intersecting face.

32. A method according to Claim 28, wherein the slider is fixed to the first and second waveguide forming regions such that a longitudinal direction of the slider is substantially parallel to the intersecting face.

33. A method according to Claim 17, further comprising:

cutting the arrayed waveguide grating along a non-intersecting face which does not intersect the optical path;

forming a bottom groove along the intersecting face on a bottom surface of the arrayed waveguide grating;

provisionally fixing the arrayed waveguide grating on a provisional fixing plate;

forming a top groove along the intersecting face on a top surface of the arrayed waveguide grating to cut the arrayed waveguide grating to first and second arrayed waveguide grating portions to divide the at least one of the first and second slab waveguides to the first and second portions;

fixing a slider to the first and second arrayed waveguide grating portions to connect

the first and second waveguide forming regions at the temperature shifted from the predetermined temperature; and

removing the provisional fixing plate from the arrayed waveguide grating.

34. A method according to Claim 17, further comprising:

forming a top groove along the intersecting face on a top surface of the arrayed waveguide grating, the top groove dividing the arrayed waveguide grating to first and second arrayed waveguide grating portions to divide the at least one of the first and second slab waveguides to the first and second portions;

fixing a slider to the first and second arrayed waveguide grating portions at the temperature shifted from the predetermined temperature; and

forming a bottom groove along the intersecting face on a bottom surface of the arrayed waveguide grating to cut the arrayed waveguide grating to first and second arrayed waveguide grating portions to divide the at least one of the first and second slab waveguides to the first and second portions.

35. An arrayed waveguide grating optical multiplexer/demultiplexer comprising:

at least one first optical waveguide;

a first slab waveguide;

an arrayed waveguide connected to said at least one first optical waveguide via said first slab waveguide;

a second slab waveguide including first and second portions which are separated along an intersecting face intersecting an optical path in the second slab waveguide;

a plurality of second optical waveguides connected to said arrayed waveguide via said second slab waveguide; and

a slider fixed at a temperature shifted from a predetermined temperature to

compensate a center wavelength difference between a target center wavelength of optical transmission of the arrayed waveguide grating optical multiplexer/demultiplexer at the predetermined temperature and the measured center wavelength of optical transmission of the arrayed waveguide grating optical multiplexer/demultiplexer at the predetermined temperature before the second slab waveguide is divided into the first and second portions, the slider being configured to cause a relative motion between the first and second portions of the second slab waveguide along the intersecting face according to a temperature change.

36. An arrayed waveguide grating optical multiplexer/demultiplexer according to Claim 35, wherein the at least one first optical waveguide, the first slab waveguide, the arrayed waveguide, the second slab waveguide, and the plurality of second optical waveguides are formed in a waveguide forming region, and wherein the slider has a thermal expansion coefficient higher than that of the waveguide forming region.

37. An arrayed waveguide grating optical multiplexer/demultiplexer according to Claim 35, wherein the intersecting face substantially vertically intersects the optical path.

38. An arrayed waveguide grating optical multiplexer/demultiplexer according to Claim 35, wherein the at least one first optical waveguide, the first slab waveguide, the arrayed waveguide, the second slab waveguide, and the plurality of second optical waveguides are formed in a waveguide forming region, and wherein dopant is doped in the waveguide forming region such that an absolute value of a birefringence of core of the waveguide forming region is at most $5.34 \times 10^{-5}$.

39. An arrayed waveguide grating optical multiplexer/demultiplexer according to Claim 38, wherein the dopant comprises $B_2O_3$ and $P_2O_5$.

40. An arrayed waveguide grating optical multiplexer/demultiplexer according to Claim 35, further comprising:

matching oil provided in a gap formed between the first and second portions and having a refractive index which matches with that of a waveguide forming region in which the at least one first optical waveguide, the first slab waveguide, the arrayed waveguide, the second slab waveguide, and the plurality of second optical waveguides are formed.

41. An arrayed waveguide grating optical multiplexer/demultiplexer according to Claim 35, wherein the slider has a length between fixed parts which are fixed to the first and second portions to compensate a temperature dependency of a center wavelength of the arrayed waveguide grating optical multiplexer/demultiplexer.

42. An arrayed waveguide grating optical multiplexer/demultiplexer according to Claim 35, wherein the temperature is shifted from the predetermined temperature by substantially a shifting temperature ($\Delta t$) which is calculated according to the following equation:

$$\Delta t = (\lambda_d - \lambda_m) / 0.011$$

where $\lambda_d$: the target center wavelength of optical transmission at the predetermined temperature

$\lambda_m$: the measured center wavelength of optical transmission of the arrayed waveguide grating optical multiplexer/demultiplexer at the predetermined temperature before the first slab waveguide is divided into the first and second portions.

43. An arrayed waveguide grating optical multiplexer/demultiplexer according to Claim 35, further comprising:

a half-wave plate provided across the array waveguide.

44. An arrayed waveguide grating optical multiplexer/demultiplexer according to Claim 35, wherein the intersecting face obliquely intersects the optical path.

45. An arrayed waveguide grating optical multiplexer/demultiplexer according to Claim 35, further comprising:

at least one clip; and

a base to which one of the first and second portions of the second slab waveguide is fixed with the at least one clip.

46. An arrayed waveguide grating optical multiplexer/demultiplexer according to Claim 35, wherein

the at least one first optical waveguide, the first slab waveguide, the arrayed waveguide, the second slab waveguide, and the plurality of second optical waveguides are formed in a waveguide forming region,

the waveguide forming region is divided to first and second waveguide forming regions to divide the second slab waveguide to the first and second portions, and

the slider is fixed to the first and second waveguide forming regions to connect the first and second waveguide forming regions at the temperature shifted from the predetermined temperature.

47. An arrayed waveguide grating optical multiplexer/demultiplexer according to Claim 35, wherein

the at least one first optical waveguide, the first slab waveguide, the arrayed waveguide, the second slab waveguide, and the plurality of second optical waveguides are formed in a waveguide forming region,

the waveguide forming region is divided to first and second waveguide forming regions to divide the second slab waveguide to the first and second portions,

one of the first and second waveguide forming regions is fixed to a base, and

the slider is fixed to the base and another of the first and second waveguide forming

regions to connect the base and the another of the first and second waveguide forming regions at the temperature shifted from the predetermined temperature.

48. An arrayed waveguide grating optical multiplexer/demultiplexer according to Claim 47, wherein the base has a U-Shape.

49. An arrayed waveguide grating optical multiplexer/demultiplexer according to Claim 46, wherein the waveguide forming region is divided to first and second waveguide forming regions along the intersecting face and a non-intersecting face which does not intersect the optical path, and wherein the slider is fixed to the first and second waveguide forming regions across the non-intersecting face.

50. An arrayed waveguide grating optical multiplexer/demultiplexer according to Claim 46, wherein the slider is fixed to the first and second waveguide forming regions such that a longitudinal direction of the slider is substantially parallel to the intersecting face.